In [ ]:
```
import pandas as pd
import numpy as np
```

In [ ]:
```
df = pd.read_csv('data/pima-indians-diabetes.csv')
df.head(10)
```

Out[ ]:

	6	148	72	35	0	33.6	0.627	50	1
0	1	85	66	29	0	26.6	0.351	31	0
1	8	183	64	0	0	23.3	0.672	32	1
2	1	89	66	23	94	28.1	0.167	21	0
3	0	137	40	35	168	43.1	2.288	33	1
4	5	116	74	0	0	25.6	0.201	30	0
5	3	78	50	32	88	31.0	0.248	26	1
6	10	115	0	0	0	35.3	0.134	29	0
7	2	197	70	45	543	30.5	0.158	53	1
8	8	125	96	0	0	0.0	0.232	54	1
9	4	110	92	0	0	37.6	0.191	30	0

In [ ]:
```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 767 entries, 0 to 766
Data columns (total 9 columns):
 #   Column  Non-Null Count  Dtype  
---  ------  --------------  -----  
 0   6       767 non-null    int64  
 1   148     767 non-null    int64  
 2   72      767 non-null    int64  
 3   35      767 non-null    int64  
 4   0       767 non-null    int64  
 5   33.6    767 non-null    float64
 6   0.627   767 non-null    float64
 7   50      767 non-null    int64  
 8   1       767 non-null    int64  
dtypes: float64(2), int64(7)
memory usage: 54.1 KB
```

In [ ]:
```
x = df.iloc[:,:8]
y = df.iloc[:,8]
```

In [ ]:
```
from sklearn.model_selection import train_test_split
```

In [ ]:
```
x_train, x_test, y_train, y_test = train_test_split(x, y, test_size=0.2, random_state=0)
```

In [ ]:
```
seed = 1
np.random.seed(seed)
```

In [ ]:
```
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Dense
```

In [ ]:
```
model1 = Sequential()
model1.add(Dense(8, input_dim = 8, activation = "relu"))
model1.add(Dense(8, activation = "relu"))
model1.add(Dense(1, activation = "sigmoid"))
model1.compile(loss='binary_crossentropy', optimizer = 'sgd', metrics = ['accuracy'])
```

In [ ]:
```
history1 = model1.fit(x_train, y_train, batch_size=8, epochs=150, validation_data=(x_test, y_test))
```

```
Epoch 1/150
77/77 [==============================] - 1s 4ms/step - loss: 0.8978 - accuracy: 0.6395 - val_loss: 0.6619 - val_
accuracy: 0.6948
Epoch 2/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6742 - accuracy: 0.6493 - val_loss: 0.6637 - val_
accuracy: 0.6623
Epoch 3/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6628 - accuracy: 0.6493 - val_loss: 0.6483 - val_
accuracy: 0.6688
Epoch 4/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6524 - accuracy: 0.6444 - val_loss: 0.6396 - val_
accuracy: 0.6688
Epoch 5/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6404 - accuracy: 0.6639 - val_loss: 0.6289 - val_
accuracy: 0.6688
Epoch 6/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6431 - accuracy: 0.6509 - val_loss: 0.6357 - val_
accuracy: 0.6623
Epoch 7/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6399 - accuracy: 0.6542 - val_loss: 0.6262 - val_
accuracy: 0.6818
Epoch 8/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6370 - accuracy: 0.6558 - val_loss: 0.6333 - val_
accuracy: 0.6688
Epoch 9/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6300 - accuracy: 0.6444 - val_loss: 0.6464 - val_
accuracy: 0.6169
Epoch 10/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6335 - accuracy: 0.6378 - val_loss: 0.6261 - val_
accuracy: 0.6623
Epoch 11/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6370 - accuracy: 0.6542 - val_loss: 0.6177 - val_
accuracy: 0.6623
Epoch 12/150
77/77 [==============================] - 0s 1ms/step - loss: 0.6291 - accuracy: 0.6542 - val_loss: 0.6052 - val_
accuracy: 0.6818
Epoch 13/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6250 - accuracy: 0.6607 - val_loss: 0.6080 - val_
accuracy: 0.6753
Epoch 14/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6259 - accuracy: 0.6623 - val_loss: 0.6295 - val_
accuracy: 0.6883
Epoch 15/150
77/77 [==============================] - 0s 1ms/step - loss: 0.6182 - accuracy: 0.6705 - val_loss: 0.6386 - val_
accuracy: 0.6169
Epoch 16/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6238 - accuracy: 0.6672 - val_loss: 0.6074 - val_
accuracy: 0.6688
Epoch 17/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6205 - accuracy: 0.6607 - val_loss: 0.6147 - val_
accuracy: 0.6688
Epoch 18/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6364 - accuracy: 0.6639 - val_loss: 0.6594 - val_
accuracy: 0.6558
Epoch 19/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6224 - accuracy: 0.6607 - val_loss: 0.6121 - val_
accuracy: 0.6688
Epoch 20/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6162 - accuracy: 0.6656 - val_loss: 0.6215 - val_
accuracy: 0.6558
Epoch 21/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6210 - accuracy: 0.6476 - val_loss: 0.6036 - val_
accuracy: 0.6818
Epoch 22/150
77/77 [==============================] - 0s 1ms/step - loss: 0.6120 - accuracy: 0.6542 - val_loss: 0.6427 - val_
accuracy: 0.6883
Epoch 23/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6124 - accuracy: 0.6558 - val_loss: 0.6013 - val_
accuracy: 0.6883
Epoch 24/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6104 - accuracy: 0.6688 - val_loss: 0.6116 - val_
accuracy: 0.6623
Epoch 25/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6114 - accuracy: 0.6639 - val_loss: 0.5931 - val_
accuracy: 0.6948
Epoch 26/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6018 - accuracy: 0.6623 - val_loss: 0.6020 - val_
accuracy: 0.6818
Epoch 27/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6130 - accuracy: 0.6607 - val_loss: 0.5789 - val_
accuracy: 0.7273
Epoch 28/150
```

```
77/77 [==============================] - 0s 2ms/step - loss: 0.6068 - accuracy: 0.6656 - val_loss: 0.6291 - val_
accuracy: 0.6883
Epoch 29/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6152 - accuracy: 0.6623 - val_loss: 0.5835 - val_
accuracy: 0.7078
Epoch 30/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6095 - accuracy: 0.6672 - val_loss: 0.6043 - val_
accuracy: 0.6948
Epoch 31/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6109 - accuracy: 0.6672 - val_loss: 0.6145 - val_
accuracy: 0.6688
Epoch 32/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6134 - accuracy: 0.6623 - val_loss: 0.5904 - val_
accuracy: 0.7013
Epoch 33/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6035 - accuracy: 0.6672 - val_loss: 0.5753 - val_
accuracy: 0.7403
Epoch 34/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6079 - accuracy: 0.6786 - val_loss: 0.5728 - val_
accuracy: 0.7468
Epoch 35/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6039 - accuracy: 0.6705 - val_loss: 0.5814 - val_
accuracy: 0.7662
Epoch 36/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5990 - accuracy: 0.6754 - val_loss: 0.5711 - val_
accuracy: 0.7273
Epoch 37/150
77/77 [==============================] - 0s 3ms/step - loss: 0.5973 - accuracy: 0.6819 - val_loss: 0.5621 - val_
accuracy: 0.7532
Epoch 38/150
77/77 [==============================] - 0s 3ms/step - loss: 0.5984 - accuracy: 0.6835 - val_loss: 0.5650 - val_
accuracy: 0.7338
Epoch 39/150
77/77 [==============================] - 0s 3ms/step - loss: 0.5975 - accuracy: 0.6835 - val_loss: 0.5648 - val_
accuracy: 0.7468
Epoch 40/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5960 - accuracy: 0.6705 - val_loss: 0.5774 - val_
accuracy: 0.6948
Epoch 41/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5910 - accuracy: 0.7031 - val_loss: 0.5833 - val_
accuracy: 0.6948
Epoch 42/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5847 - accuracy: 0.6966 - val_loss: 0.6071 - val_
accuracy: 0.6429
Epoch 43/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5895 - accuracy: 0.6966 - val_loss: 0.5733 - val_
accuracy: 0.7403
Epoch 44/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5875 - accuracy: 0.6737 - val_loss: 0.5973 - val_
accuracy: 0.6364
Epoch 45/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5944 - accuracy: 0.6803 - val_loss: 0.5734 - val_
accuracy: 0.6818
Epoch 46/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5827 - accuracy: 0.7113 - val_loss: 0.5692 - val_
accuracy: 0.7013
Epoch 47/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5871 - accuracy: 0.6982 - val_loss: 0.6182 - val_
accuracy: 0.6299
Epoch 48/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5913 - accuracy: 0.6966 - val_loss: 0.5754 - val_
accuracy: 0.6948
Epoch 49/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5880 - accuracy: 0.6884 - val_loss: 0.5458 - val_
accuracy: 0.7727
Epoch 50/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5782 - accuracy: 0.6982 - val_loss: 0.5611 - val_
accuracy: 0.6883
Epoch 51/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5838 - accuracy: 0.6868 - val_loss: 0.5449 - val_
accuracy: 0.7468
Epoch 52/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5797 - accuracy: 0.6998 - val_loss: 0.5658 - val_
accuracy: 0.7013
Epoch 53/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5817 - accuracy: 0.7015 - val_loss: 0.5570 - val_
accuracy: 0.7143
Epoch 54/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5748 - accuracy: 0.6933 - val_loss: 0.6006 - val_
accuracy: 0.6558
Epoch 55/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5868 - accuracy: 0.7064 - val_loss: 0.5441 - val_
```

```
accuracy: 0.7662
Epoch 56/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5880 - accuracy: 0.7031 - val_loss: 0.5875 - val_
accuracy: 0.7078
Epoch 57/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5883 - accuracy: 0.6900 - val_loss: 0.5487 - val_
accuracy: 0.7532
Epoch 58/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5771 - accuracy: 0.7015 - val_loss: 0.5484 - val_
accuracy: 0.7013
Epoch 59/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5696 - accuracy: 0.6966 - val_loss: 0.5480 - val_
accuracy: 0.7013
Epoch 60/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5727 - accuracy: 0.6982 - val_loss: 0.5422 - val_
accuracy: 0.7338
Epoch 61/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5679 - accuracy: 0.7129 - val_loss: 0.5417 - val_
accuracy: 0.7857
Epoch 62/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5748 - accuracy: 0.6998 - val_loss: 0.5530 - val_
accuracy: 0.7403
Epoch 63/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5743 - accuracy: 0.7080 - val_loss: 0.5685 - val_
accuracy: 0.6818
Epoch 64/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5674 - accuracy: 0.7080 - val_loss: 0.5694 - val_
accuracy: 0.7273
Epoch 65/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5668 - accuracy: 0.7096 - val_loss: 0.5436 - val_
accuracy: 0.7468
Epoch 66/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5742 - accuracy: 0.7259 - val_loss: 0.5437 - val_
accuracy: 0.7532
Epoch 67/150
77/77 [==============================] - 0s 3ms/step - loss: 0.5580 - accuracy: 0.7047 - val_loss: 0.5422 - val_
accuracy: 0.7532
Epoch 68/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5671 - accuracy: 0.7047 - val_loss: 0.5365 - val_
accuracy: 0.7403
Epoch 69/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5639 - accuracy: 0.7113 - val_loss: 0.5180 - val_
accuracy: 0.7597
Epoch 70/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5610 - accuracy: 0.7096 - val_loss: 0.5443 - val_
accuracy: 0.7468
Epoch 71/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5744 - accuracy: 0.7113 - val_loss: 0.5333 - val_
accuracy: 0.7597
Epoch 72/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5677 - accuracy: 0.7047 - val_loss: 0.5396 - val_
accuracy: 0.7273
Epoch 73/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5643 - accuracy: 0.7325 - val_loss: 0.5270 - val_
accuracy: 0.7792
Epoch 74/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5732 - accuracy: 0.7096 - val_loss: 0.5845 - val_
accuracy: 0.6753
Epoch 75/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5648 - accuracy: 0.7243 - val_loss: 0.5362 - val_
accuracy: 0.7273
Epoch 76/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5585 - accuracy: 0.7325 - val_loss: 0.5993 - val_
accuracy: 0.6753
Epoch 77/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5625 - accuracy: 0.7210 - val_loss: 0.5229 - val_
accuracy: 0.7597
Epoch 78/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5621 - accuracy: 0.7145 - val_loss: 0.5371 - val_
accuracy: 0.7662
Epoch 79/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5554 - accuracy: 0.7308 - val_loss: 0.5249 - val_
accuracy: 0.7662
Epoch 80/150
77/77 [==============================] - 0s 2ms/step - loss: 0.7392 - accuracy: 0.6868 - val_loss: 0.5345 - val_
accuracy: 0.7273
Epoch 81/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5843 - accuracy: 0.6933 - val_loss: 0.6436 - val_
accuracy: 0.5974
Epoch 82/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5755 - accuracy: 0.6982 - val_loss: 0.5607 - val_
accuracy: 0.7013
```

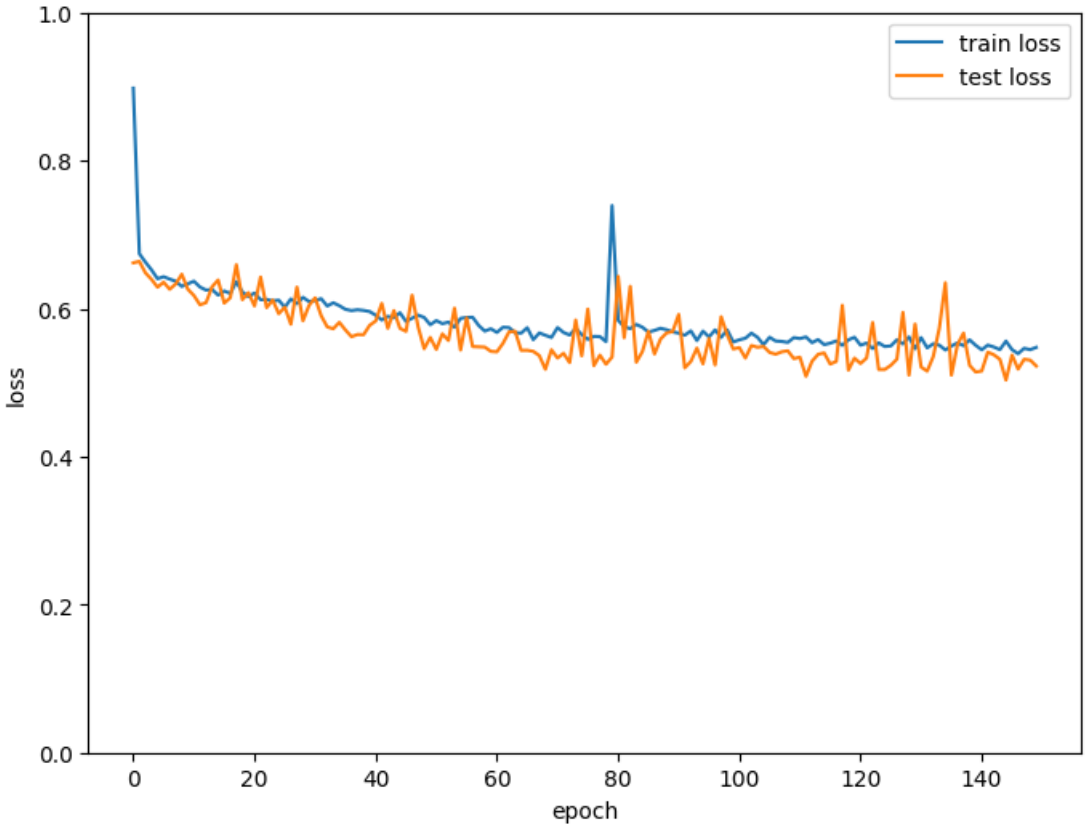
```
Epoch 83/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5730 - accuracy: 0.7210 - val_loss: 0.6301 - val_
accuracy: 0.6039
Epoch 84/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5786 - accuracy: 0.7129 - val_loss: 0.5276 - val_
accuracy: 0.7532
Epoch 85/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5749 - accuracy: 0.7194 - val_loss: 0.5418 - val_
accuracy: 0.7273
Epoch 86/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5683 - accuracy: 0.7210 - val_loss: 0.5693 - val_
accuracy: 0.7078
Epoch 87/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5705 - accuracy: 0.7015 - val_loss: 0.5386 - val_
accuracy: 0.7338
Epoch 88/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5734 - accuracy: 0.7031 - val_loss: 0.5588 - val_
accuracy: 0.6883
Epoch 89/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5715 - accuracy: 0.7047 - val_loss: 0.5671 - val_
accuracy: 0.7013
Epoch 90/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5686 - accuracy: 0.7113 - val_loss: 0.5690 - val_
accuracy: 0.6948
Epoch 91/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5669 - accuracy: 0.7308 - val_loss: 0.5922 - val_
accuracy: 0.6429
Epoch 92/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5641 - accuracy: 0.7259 - val_loss: 0.5200 - val_
accuracy: 0.7338
Epoch 93/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5699 - accuracy: 0.7145 - val_loss: 0.5286 - val_
accuracy: 0.7143
Epoch 94/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5569 - accuracy: 0.7194 - val_loss: 0.5466 - val_
accuracy: 0.7338
Epoch 95/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5696 - accuracy: 0.6982 - val_loss: 0.5254 - val_
accuracy: 0.7403
Epoch 96/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5616 - accuracy: 0.7243 - val_loss: 0.5597 - val_
accuracy: 0.6948
Epoch 97/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5713 - accuracy: 0.7210 - val_loss: 0.5238 - val_
accuracy: 0.7597
Epoch 98/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5611 - accuracy: 0.7113 - val_loss: 0.5890 - val_
accuracy: 0.7013
Epoch 99/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5712 - accuracy: 0.6982 - val_loss: 0.5646 - val_
accuracy: 0.6688
Epoch 100/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5549 - accuracy: 0.7129 - val_loss: 0.5454 - val_
accuracy: 0.7143
Epoch 101/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5578 - accuracy: 0.7162 - val_loss: 0.5474 - val_
accuracy: 0.7273
Epoch 102/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5599 - accuracy: 0.7357 - val_loss: 0.5332 - val_
accuracy: 0.7273
Epoch 103/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5668 - accuracy: 0.6966 - val_loss: 0.5501 - val_
accuracy: 0.7013
Epoch 104/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5613 - accuracy: 0.7210 - val_loss: 0.5477 - val_
accuracy: 0.7208
Epoch 105/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5513 - accuracy: 0.7276 - val_loss: 0.5489 - val_
accuracy: 0.7143
Epoch 106/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5613 - accuracy: 0.6949 - val_loss: 0.5408 - val_
accuracy: 0.7208
Epoch 107/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5562 - accuracy: 0.7357 - val_loss: 0.5384 - val_
accuracy: 0.7338
Epoch 108/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5557 - accuracy: 0.7113 - val_loss: 0.5416 - val_
accuracy: 0.7273
Epoch 109/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5543 - accuracy: 0.7129 - val_loss: 0.5429 - val_
accuracy: 0.7143
Epoch 110/150
```

```
77/77 [==============================] - 0s 2ms/step - loss: 0.5608 - accuracy: 0.7080 - val_loss: 0.5324 - val_
accuracy: 0.7597
Epoch 111/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5595 - accuracy: 0.7210 - val_loss: 0.5343 - val_
accuracy: 0.7403
Epoch 112/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5616 - accuracy: 0.7210 - val_loss: 0.5085 - val_
accuracy: 0.7662
Epoch 113/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5540 - accuracy: 0.7145 - val_loss: 0.5289 - val_
accuracy: 0.7468
Epoch 114/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5581 - accuracy: 0.7227 - val_loss: 0.5382 - val_
accuracy: 0.7338
Epoch 115/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5513 - accuracy: 0.7194 - val_loss: 0.5401 - val_
accuracy: 0.7143
Epoch 116/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5533 - accuracy: 0.7162 - val_loss: 0.5251 - val_
accuracy: 0.7532
Epoch 117/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5562 - accuracy: 0.7292 - val_loss: 0.5286 - val_
accuracy: 0.7208
Epoch 118/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5505 - accuracy: 0.7325 - val_loss: 0.6044 - val_
accuracy: 0.6753
Epoch 119/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5578 - accuracy: 0.7194 - val_loss: 0.5168 - val_
accuracy: 0.7403
Epoch 120/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5612 - accuracy: 0.7259 - val_loss: 0.5331 - val_
accuracy: 0.7143
Epoch 121/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5507 - accuracy: 0.7325 - val_loss: 0.5258 - val_
accuracy: 0.7143
Epoch 122/150
77/77 [==============================] - 0s 3ms/step - loss: 0.5534 - accuracy: 0.6982 - val_loss: 0.5332 - val_
accuracy: 0.7208
Epoch 123/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5461 - accuracy: 0.7243 - val_loss: 0.5811 - val_
accuracy: 0.6818
Epoch 124/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5538 - accuracy: 0.7243 - val_loss: 0.5178 - val_
accuracy: 0.7857
Epoch 125/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5488 - accuracy: 0.7227 - val_loss: 0.5178 - val_
accuracy: 0.7403
Epoch 126/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5496 - accuracy: 0.7259 - val_loss: 0.5234 - val_
accuracy: 0.7532
Epoch 127/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5578 - accuracy: 0.7341 - val_loss: 0.5316 - val_
accuracy: 0.7338
Epoch 128/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5523 - accuracy: 0.7308 - val_loss: 0.5948 - val_
accuracy: 0.6494
Epoch 129/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5617 - accuracy: 0.7047 - val_loss: 0.5101 - val_
accuracy: 0.7727
Epoch 130/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5459 - accuracy: 0.7341 - val_loss: 0.5791 - val_
accuracy: 0.6948
Epoch 131/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5608 - accuracy: 0.6982 - val_loss: 0.5210 - val_
accuracy: 0.7532
Epoch 132/150
77/77 [==============================] - 0s 3ms/step - loss: 0.5469 - accuracy: 0.7145 - val_loss: 0.5155 - val_
accuracy: 0.7468
Epoch 133/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5525 - accuracy: 0.7243 - val_loss: 0.5352 - val_
accuracy: 0.7273
Epoch 134/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5506 - accuracy: 0.7194 - val_loss: 0.5733 - val_
accuracy: 0.6623
Epoch 135/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5441 - accuracy: 0.7308 - val_loss: 0.6349 - val_
accuracy: 0.6494
Epoch 136/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5495 - accuracy: 0.7047 - val_loss: 0.5101 - val_
accuracy: 0.7727
Epoch 137/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5537 - accuracy: 0.7178 - val_loss: 0.5514 - val_
```

```
accuracy: 0.7338
Epoch 138/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5500 - accuracy: 0.7210 - val_loss: 0.5669 - val_
accuracy: 0.6948
Epoch 139/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5578 - accuracy: 0.7113 - val_loss: 0.5234 - val_
accuracy: 0.7403
Epoch 140/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5504 - accuracy: 0.7113 - val_loss: 0.5144 - val_
accuracy: 0.7403
Epoch 141/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5444 - accuracy: 0.7374 - val_loss: 0.5156 - val_
accuracy: 0.7338
Epoch 142/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5507 - accuracy: 0.7259 - val_loss: 0.5411 - val_
accuracy: 0.6948
Epoch 143/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5481 - accuracy: 0.7096 - val_loss: 0.5376 - val_
accuracy: 0.7143
Epoch 144/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5446 - accuracy: 0.7080 - val_loss: 0.5315 - val_
accuracy: 0.7338
Epoch 145/150
77/77 [==============================] - 0s 4ms/step - loss: 0.5560 - accuracy: 0.7145 - val_loss: 0.5034 - val_
accuracy: 0.7857
Epoch 146/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5446 - accuracy: 0.7243 - val_loss: 0.5373 - val_
accuracy: 0.7338
Epoch 147/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5391 - accuracy: 0.7341 - val_loss: 0.5183 - val_
accuracy: 0.7403
Epoch 148/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5463 - accuracy: 0.7129 - val_loss: 0.5315 - val_
accuracy: 0.7338
Epoch 149/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5445 - accuracy: 0.7292 - val_loss: 0.5304 - val_
accuracy: 0.7338
Epoch 150/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5476 - accuracy: 0.6933 - val_loss: 0.5224 - val_
accuracy: 0.7597
```

In [ ]:
```
import matplotlib.pyplot as plt
```

In [ ]:
```
plt.figure(figsize=(8,6))
plt.plot(history1.history['loss'])
plt.plot(history1.history['val_loss'])
plt.ylim(0,1)
plt.ylabel('loss')
plt.xlabel('epoch')
plt.legend(['train loss','test loss'], loc="upper right")
plt.show()
```



In [ ]:
```
print("Maximum accuracy on test data", max(history1.history['val_accuracy']))
```

```
Maximum accuracy on test data 0.7857142686843872
```

L2 Regularisation

In [ ]:
```
from tensorflow.keras.regularizers import l2
```

In [ ]:
```
model2 = Sequential()
model2.add(Dense(8, input_dim = 8, activation = "relu", kernel_regularizer=l2(0.01)))
model2.add(Dense(8, activation = "relu", kernel_regularizer=l2(0.01)))
model2.add(Dense(1, activation = "sigmoid"))
model2.compile(loss='binary_crossentropy', optimizer = 'sgd', metrics = ['accuracy'])
```

In [ ]:
```
history2 = model2.fit(x_train, y_train, batch_size=8, epochs=150, validation_data=(x_test, y_test))
```

```
Epoch 1/150
77/77 [==============================] - 1s 3ms/step - loss: 1.8899 - accuracy: 0.6313 - val_loss: 0.8338 - val_
accuracy: 0.6494
Epoch 2/150
77/77 [==============================] - 0s 2ms/step - loss: 0.8261 - accuracy: 0.6509 - val_loss: 0.8187 - val_
accuracy: 0.6558
Epoch 3/150
77/77 [==============================] - 0s 1ms/step - loss: 0.8133 - accuracy: 0.6525 - val_loss: 0.8069 - val_
accuracy: 0.6558
Epoch 4/150
77/77 [==============================] - 0s 2ms/step - loss: 0.8030 - accuracy: 0.6525 - val_loss: 0.7975 - val_
accuracy: 0.6558
Epoch 5/150
77/77 [==============================] - 0s 2ms/step - loss: 0.7948 - accuracy: 0.6525 - val_loss: 0.7897 - val_
accuracy: 0.6558
Epoch 6/150
77/77 [==============================] - 0s 1ms/step - loss: 0.7879 - accuracy: 0.6525 - val_loss: 0.7833 - val_
accuracy: 0.6558
Epoch 7/150
77/77 [==============================] - 0s 2ms/step - loss: 0.7819 - accuracy: 0.6525 - val_loss: 0.7775 - val_
accuracy: 0.6558
Epoch 8/150
77/77 [==============================] - 0s 2ms/step - loss: 0.7766 - accuracy: 0.6525 - val_loss: 0.7725 - val_
accuracy: 0.6558
Epoch 9/150
77/77 [==============================] - 0s 2ms/step - loss: 0.7719 - accuracy: 0.6525 - val_loss: 0.7678 - val_
accuracy: 0.6558
Epoch 10/150
77/77 [==============================] - 0s 2ms/step - loss: 0.7675 - accuracy: 0.6525 - val_loss: 0.7635 - val_
accuracy: 0.6558
Epoch 11/150
77/77 [==============================] - 0s 2ms/step - loss: 0.7635 - accuracy: 0.6525 - val_loss: 0.7596 - val_
accuracy: 0.6558
Epoch 12/150
77/77 [==============================] - 0s 2ms/step - loss: 0.7596 - accuracy: 0.6525 - val_loss: 0.7558 - val_
accuracy: 0.6558
Epoch 13/150
77/77 [==============================] - 0s 2ms/step - loss: 0.7560 - accuracy: 0.6525 - val_loss: 0.7522 - val_
accuracy: 0.6558
Epoch 14/150
77/77 [==============================] - 0s 2ms/step - loss: 0.7525 - accuracy: 0.6525 - val_loss: 0.7487 - val_
accuracy: 0.6558
Epoch 15/150
77/77 [==============================] - 0s 2ms/step - loss: 0.7492 - accuracy: 0.6525 - val_loss: 0.7455 - val_
accuracy: 0.6558
Epoch 16/150
77/77 [==============================] - 0s 2ms/step - loss: 0.7460 - accuracy: 0.6525 - val_loss: 0.7423 - val_
accuracy: 0.6558
Epoch 17/150
77/77 [==============================] - 0s 2ms/step - loss: 0.7429 - accuracy: 0.6542 - val_loss: 0.7393 - val_
accuracy: 0.6558
Epoch 18/150
77/77 [==============================] - 0s 2ms/step - loss: 0.7400 - accuracy: 0.6525 - val_loss: 0.7364 - val_
accuracy: 0.6558
Epoch 19/150
77/77 [==============================] - 0s 2ms/step - loss: 0.7371 - accuracy: 0.6525 - val_loss: 0.7335 - val_
accuracy: 0.6558
Epoch 20/150
77/77 [==============================] - 0s 2ms/step - loss: 0.7343 - accuracy: 0.6525 - val_loss: 0.7309 - val_
accuracy: 0.6558
Epoch 21/150
77/77 [==============================] - 0s 2ms/step - loss: 0.7316 - accuracy: 0.6525 - val_loss: 0.7282 - val_
accuracy: 0.6558
Epoch 22/150
77/77 [==============================] - 0s 3ms/step - loss: 0.7290 - accuracy: 0.6542 - val_loss: 0.7257 - val_
accuracy: 0.6558
Epoch 23/150
77/77 [==============================] - 0s 2ms/step - loss: 0.7266 - accuracy: 0.6525 - val_loss: 0.7232 - val_
accuracy: 0.6558
Epoch 24/150
77/77 [==============================] - 0s 2ms/step - loss: 0.7241 - accuracy: 0.6542 - val_loss: 0.7208 - val_
accuracy: 0.6558
Epoch 25/150
77/77 [==============================] - 0s 2ms/step - loss: 0.7217 - accuracy: 0.6525 - val_loss: 0.7185 - val_
accuracy: 0.6558
Epoch 26/150
77/77 [==============================] - 0s 2ms/step - loss: 0.7195 - accuracy: 0.6542 - val_loss: 0.7163 - val_
accuracy: 0.6558
Epoch 27/150
77/77 [==============================] - 0s 2ms/step - loss: 0.7172 - accuracy: 0.6542 - val_loss: 0.7141 - val_
accuracy: 0.6558
Epoch 28/150
```

```
77/77 [==============================] - 0s 2ms/step - loss: 0.7151 - accuracy: 0.6542 - val_loss: 0.7120 - val_
accuracy: 0.6558
Epoch 29/150
77/77 [==============================] - 0s 2ms/step - loss: 0.7130 - accuracy: 0.6542 - val_loss: 0.7100 - val_
accuracy: 0.6558
Epoch 30/150
77/77 [==============================] - 0s 2ms/step - loss: 0.7110 - accuracy: 0.6525 - val_loss: 0.7081 - val_
accuracy: 0.6558
Epoch 31/150
77/77 [==============================] - 0s 2ms/step - loss: 0.7091 - accuracy: 0.6525 - val_loss: 0.7061 - val_
accuracy: 0.6558
Epoch 32/150
77/77 [==============================] - 0s 2ms/step - loss: 0.7071 - accuracy: 0.6525 - val_loss: 0.7043 - val_
accuracy: 0.6558
Epoch 33/150
77/77 [==============================] - 0s 2ms/step - loss: 0.7053 - accuracy: 0.6525 - val_loss: 0.7025 - val_
accuracy: 0.6558
Epoch 34/150
77/77 [==============================] - 0s 2ms/step - loss: 0.7036 - accuracy: 0.6525 - val_loss: 0.7008 - val_
accuracy: 0.6558
Epoch 35/150
77/77 [==============================] - 0s 2ms/step - loss: 0.7018 - accuracy: 0.6525 - val_loss: 0.6991 - val_
accuracy: 0.6558
Epoch 36/150
77/77 [==============================] - 0s 2ms/step - loss: 0.7001 - accuracy: 0.6542 - val_loss: 0.6975 - val_
accuracy: 0.6558
Epoch 37/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6985 - accuracy: 0.6525 - val_loss: 0.6959 - val_
accuracy: 0.6558
Epoch 38/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6970 - accuracy: 0.6525 - val_loss: 0.6944 - val_
accuracy: 0.6558
Epoch 39/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6954 - accuracy: 0.6525 - val_loss: 0.6928 - val_
accuracy: 0.6558
Epoch 40/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6940 - accuracy: 0.6542 - val_loss: 0.6915 - val_
accuracy: 0.6558
Epoch 41/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6925 - accuracy: 0.6542 - val_loss: 0.6901 - val_
accuracy: 0.6558
Epoch 42/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6911 - accuracy: 0.6542 - val_loss: 0.6887 - val_
accuracy: 0.6558
Epoch 43/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6898 - accuracy: 0.6525 - val_loss: 0.6874 - val_
accuracy: 0.6558
Epoch 44/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6885 - accuracy: 0.6542 - val_loss: 0.6862 - val_
accuracy: 0.6558
Epoch 45/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6872 - accuracy: 0.6542 - val_loss: 0.6850 - val_
accuracy: 0.6558
Epoch 46/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6860 - accuracy: 0.6542 - val_loss: 0.6838 - val_
accuracy: 0.6558
Epoch 47/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6848 - accuracy: 0.6525 - val_loss: 0.6826 - val_
accuracy: 0.6558
Epoch 48/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6837 - accuracy: 0.6542 - val_loss: 0.6815 - val_
accuracy: 0.6558
Epoch 49/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6825 - accuracy: 0.6542 - val_loss: 0.6805 - val_
accuracy: 0.6558
Epoch 50/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6814 - accuracy: 0.6525 - val_loss: 0.6794 - val_
accuracy: 0.6558
Epoch 51/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6804 - accuracy: 0.6525 - val_loss: 0.6783 - val_
accuracy: 0.6558
Epoch 52/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6794 - accuracy: 0.6525 - val_loss: 0.6773 - val_
accuracy: 0.6558
Epoch 53/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6784 - accuracy: 0.6542 - val_loss: 0.6764 - val_
accuracy: 0.6558
Epoch 54/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6774 - accuracy: 0.6542 - val_loss: 0.6754 - val_
accuracy: 0.6558
Epoch 55/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6765 - accuracy: 0.6542 - val_loss: 0.6745 - val_
```

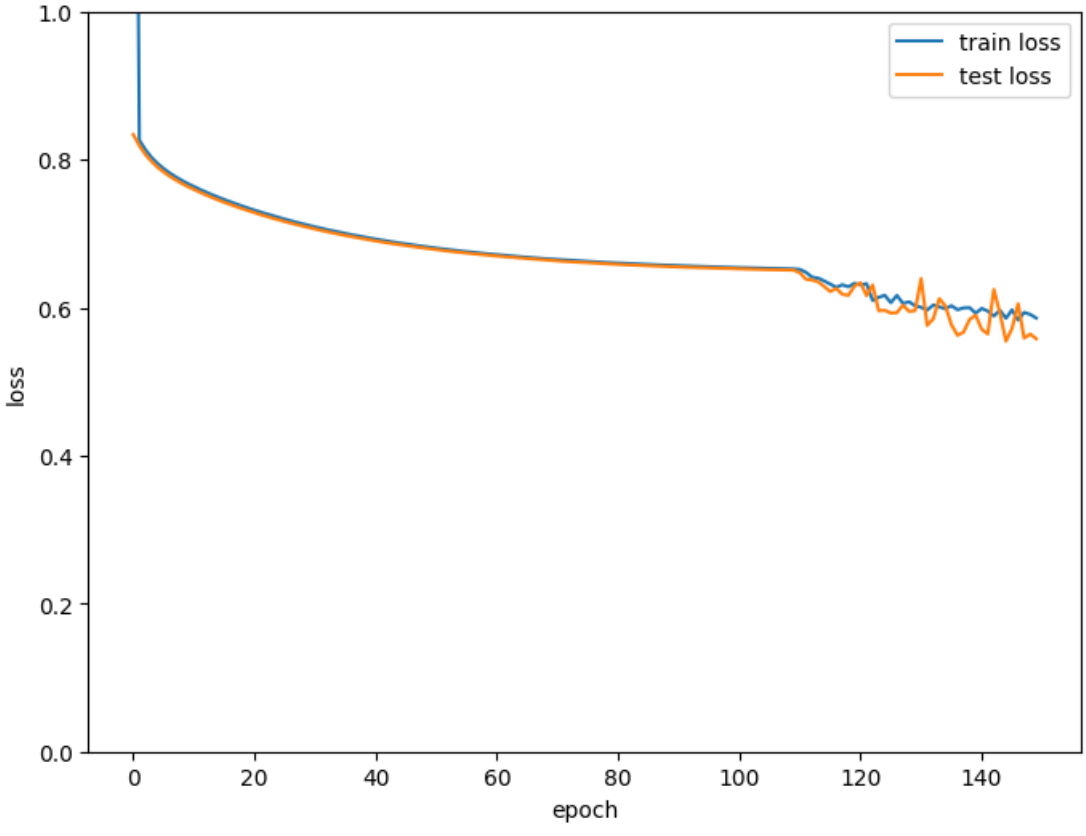
```
accuracy: 0.6558
Epoch 56/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6756 - accuracy: 0.6542 - val_loss: 0.6737 - val_
accuracy: 0.6558
Epoch 57/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6747 - accuracy: 0.6542 - val_loss: 0.6728 - val_
accuracy: 0.6558
Epoch 58/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6739 - accuracy: 0.6542 - val_loss: 0.6720 - val_
accuracy: 0.6558
Epoch 59/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6730 - accuracy: 0.6542 - val_loss: 0.6713 - val_
accuracy: 0.6558
Epoch 60/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6723 - accuracy: 0.6525 - val_loss: 0.6705 - val_
accuracy: 0.6558
Epoch 61/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6715 - accuracy: 0.6542 - val_loss: 0.6697 - val_
accuracy: 0.6558
Epoch 62/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6707 - accuracy: 0.6542 - val_loss: 0.6690 - val_
accuracy: 0.6558
Epoch 63/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6700 - accuracy: 0.6542 - val_loss: 0.6683 - val_
accuracy: 0.6558
Epoch 64/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6693 - accuracy: 0.6542 - val_loss: 0.6676 - val_
accuracy: 0.6558
Epoch 65/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6686 - accuracy: 0.6542 - val_loss: 0.6669 - val_
accuracy: 0.6558
Epoch 66/150
77/77 [==============================] - 0s 3ms/step - loss: 0.6679 - accuracy: 0.6542 - val_loss: 0.6663 - val_
accuracy: 0.6558
Epoch 67/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6673 - accuracy: 0.6542 - val_loss: 0.6656 - val_
accuracy: 0.6558
Epoch 68/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6667 - accuracy: 0.6542 - val_loss: 0.6649 - val_
accuracy: 0.6558
Epoch 69/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6661 - accuracy: 0.6542 - val_loss: 0.6643 - val_
accuracy: 0.6558
Epoch 70/150
77/77 [==============================] - 0s 3ms/step - loss: 0.6655 - accuracy: 0.6542 - val_loss: 0.6637 - val_
accuracy: 0.6558
Epoch 71/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6650 - accuracy: 0.6542 - val_loss: 0.6631 - val_
accuracy: 0.6558
Epoch 72/150
77/77 [==============================] - 0s 3ms/step - loss: 0.6644 - accuracy: 0.6542 - val_loss: 0.6626 - val_
accuracy: 0.6558
Epoch 73/150
77/77 [==============================] - 0s 3ms/step - loss: 0.6639 - accuracy: 0.6542 - val_loss: 0.6621 - val_
accuracy: 0.6558
Epoch 74/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6634 - accuracy: 0.6542 - val_loss: 0.6616 - val_
accuracy: 0.6558
Epoch 75/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6628 - accuracy: 0.6542 - val_loss: 0.6610 - val_
accuracy: 0.6558
Epoch 76/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6624 - accuracy: 0.6542 - val_loss: 0.6606 - val_
accuracy: 0.6558
Epoch 77/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6619 - accuracy: 0.6542 - val_loss: 0.6601 - val_
accuracy: 0.6558
Epoch 78/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6614 - accuracy: 0.6542 - val_loss: 0.6597 - val_
accuracy: 0.6558
Epoch 79/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6610 - accuracy: 0.6542 - val_loss: 0.6592 - val_
accuracy: 0.6558
Epoch 80/150
77/77 [==============================] - 0s 3ms/step - loss: 0.6606 - accuracy: 0.6542 - val_loss: 0.6588 - val_
accuracy: 0.6558
Epoch 81/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6602 - accuracy: 0.6542 - val_loss: 0.6584 - val_
accuracy: 0.6558
Epoch 82/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6597 - accuracy: 0.6542 - val_loss: 0.6580 - val_
accuracy: 0.6558
```

```
Epoch 83/150
77/77 [==============================] - 0s 3ms/step - loss: 0.6594 - accuracy: 0.6542 - val_loss: 0.6576 - val_
accuracy: 0.6558
Epoch 84/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6590 - accuracy: 0.6542 - val_loss: 0.6573 - val_
accuracy: 0.6558
Epoch 85/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6586 - accuracy: 0.6542 - val_loss: 0.6569 - val_
accuracy: 0.6558
Epoch 86/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6583 - accuracy: 0.6542 - val_loss: 0.6565 - val_
accuracy: 0.6558
Epoch 87/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6580 - accuracy: 0.6542 - val_loss: 0.6561 - val_
accuracy: 0.6558
Epoch 88/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6576 - accuracy: 0.6542 - val_loss: 0.6559 - val_
accuracy: 0.6558
Epoch 89/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6573 - accuracy: 0.6542 - val_loss: 0.6556 - val_
accuracy: 0.6558
Epoch 90/150
77/77 [==============================] - 0s 3ms/step - loss: 0.6570 - accuracy: 0.6542 - val_loss: 0.6553 - val_
accuracy: 0.6558
Epoch 91/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6567 - accuracy: 0.6542 - val_loss: 0.6550 - val_
accuracy: 0.6558
Epoch 92/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6564 - accuracy: 0.6542 - val_loss: 0.6546 - val_
accuracy: 0.6558
Epoch 93/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6561 - accuracy: 0.6542 - val_loss: 0.6544 - val_
accuracy: 0.6558
Epoch 94/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6558 - accuracy: 0.6525 - val_loss: 0.6541 - val_
accuracy: 0.6558
Epoch 95/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6555 - accuracy: 0.6542 - val_loss: 0.6538 - val_
accuracy: 0.6558
Epoch 96/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6553 - accuracy: 0.6542 - val_loss: 0.6535 - val_
accuracy: 0.6558
Epoch 97/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6550 - accuracy: 0.6542 - val_loss: 0.6533 - val_
accuracy: 0.6558
Epoch 98/150
77/77 [==============================] - 0s 3ms/step - loss: 0.6548 - accuracy: 0.6542 - val_loss: 0.6530 - val_
accuracy: 0.6558
Epoch 99/150
77/77 [==============================] - 0s 3ms/step - loss: 0.6545 - accuracy: 0.6542 - val_loss: 0.6527 - val_
accuracy: 0.6558
Epoch 100/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6543 - accuracy: 0.6542 - val_loss: 0.6525 - val_
accuracy: 0.6558
Epoch 101/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6541 - accuracy: 0.6542 - val_loss: 0.6523 - val_
accuracy: 0.6558
Epoch 102/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6538 - accuracy: 0.6542 - val_loss: 0.6521 - val_
accuracy: 0.6558
Epoch 103/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6536 - accuracy: 0.6542 - val_loss: 0.6518 - val_
accuracy: 0.6558
Epoch 104/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6535 - accuracy: 0.6509 - val_loss: 0.6516 - val_
accuracy: 0.6558
Epoch 105/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6533 - accuracy: 0.6525 - val_loss: 0.6515 - val_
accuracy: 0.6558
Epoch 106/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6531 - accuracy: 0.6542 - val_loss: 0.6513 - val_
accuracy: 0.6558
Epoch 107/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6528 - accuracy: 0.6509 - val_loss: 0.6512 - val_
accuracy: 0.6558
Epoch 108/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6526 - accuracy: 0.6525 - val_loss: 0.6510 - val_
accuracy: 0.6558
Epoch 109/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6524 - accuracy: 0.6542 - val_loss: 0.6508 - val_
accuracy: 0.6558
Epoch 110/150
```

```
77/77 [==============================] - 0s 2ms/step - loss: 0.6522 - accuracy: 0.6525 - val_loss: 0.6506 - val_
accuracy: 0.6558
Epoch 111/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6516 - accuracy: 0.6525 - val_loss: 0.6469 - val_
accuracy: 0.6558
Epoch 112/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6477 - accuracy: 0.6525 - val_loss: 0.6383 - val_
accuracy: 0.6558
Epoch 113/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6412 - accuracy: 0.6591 - val_loss: 0.6373 - val_
accuracy: 0.7078
Epoch 114/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6398 - accuracy: 0.6607 - val_loss: 0.6349 - val_
accuracy: 0.6494
Epoch 115/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6361 - accuracy: 0.6542 - val_loss: 0.6286 - val_
accuracy: 0.6494
Epoch 116/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6319 - accuracy: 0.6672 - val_loss: 0.6218 - val_
accuracy: 0.6558
Epoch 117/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6275 - accuracy: 0.6705 - val_loss: 0.6258 - val_
accuracy: 0.6753
Epoch 118/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6308 - accuracy: 0.6770 - val_loss: 0.6181 - val_
accuracy: 0.7468
Epoch 119/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6282 - accuracy: 0.6835 - val_loss: 0.6167 - val_
accuracy: 0.6948
Epoch 120/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6327 - accuracy: 0.6737 - val_loss: 0.6291 - val_
accuracy: 0.6688
Epoch 121/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6306 - accuracy: 0.6737 - val_loss: 0.6336 - val_
accuracy: 0.6623
Epoch 122/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6323 - accuracy: 0.6754 - val_loss: 0.6162 - val_
accuracy: 0.7013
Epoch 123/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6097 - accuracy: 0.6982 - val_loss: 0.6306 - val_
accuracy: 0.6558
Epoch 124/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6139 - accuracy: 0.6819 - val_loss: 0.5958 - val_
accuracy: 0.7922
Epoch 125/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6167 - accuracy: 0.6852 - val_loss: 0.5963 - val_
accuracy: 0.7338
Epoch 126/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6066 - accuracy: 0.6835 - val_loss: 0.5927 - val_
accuracy: 0.7727
Epoch 127/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6165 - accuracy: 0.6852 - val_loss: 0.5931 - val_
accuracy: 0.7468
Epoch 128/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6056 - accuracy: 0.6900 - val_loss: 0.6033 - val_
accuracy: 0.6688
Epoch 129/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6078 - accuracy: 0.6884 - val_loss: 0.5949 - val_
accuracy: 0.6688
Epoch 130/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6026 - accuracy: 0.6949 - val_loss: 0.5959 - val_
accuracy: 0.7078
Epoch 131/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6004 - accuracy: 0.6949 - val_loss: 0.6391 - val_
accuracy: 0.6169
Epoch 132/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5967 - accuracy: 0.6966 - val_loss: 0.5760 - val_
accuracy: 0.7078
Epoch 133/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6035 - accuracy: 0.6819 - val_loss: 0.5849 - val_
accuracy: 0.6883
Epoch 134/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6011 - accuracy: 0.7015 - val_loss: 0.6120 - val_
accuracy: 0.6558
Epoch 135/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5985 - accuracy: 0.6949 - val_loss: 0.6022 - val_
accuracy: 0.6558
Epoch 136/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6026 - accuracy: 0.6868 - val_loss: 0.5768 - val_
accuracy: 0.7143
Epoch 137/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5971 - accuracy: 0.7031 - val_loss: 0.5627 - val_
```

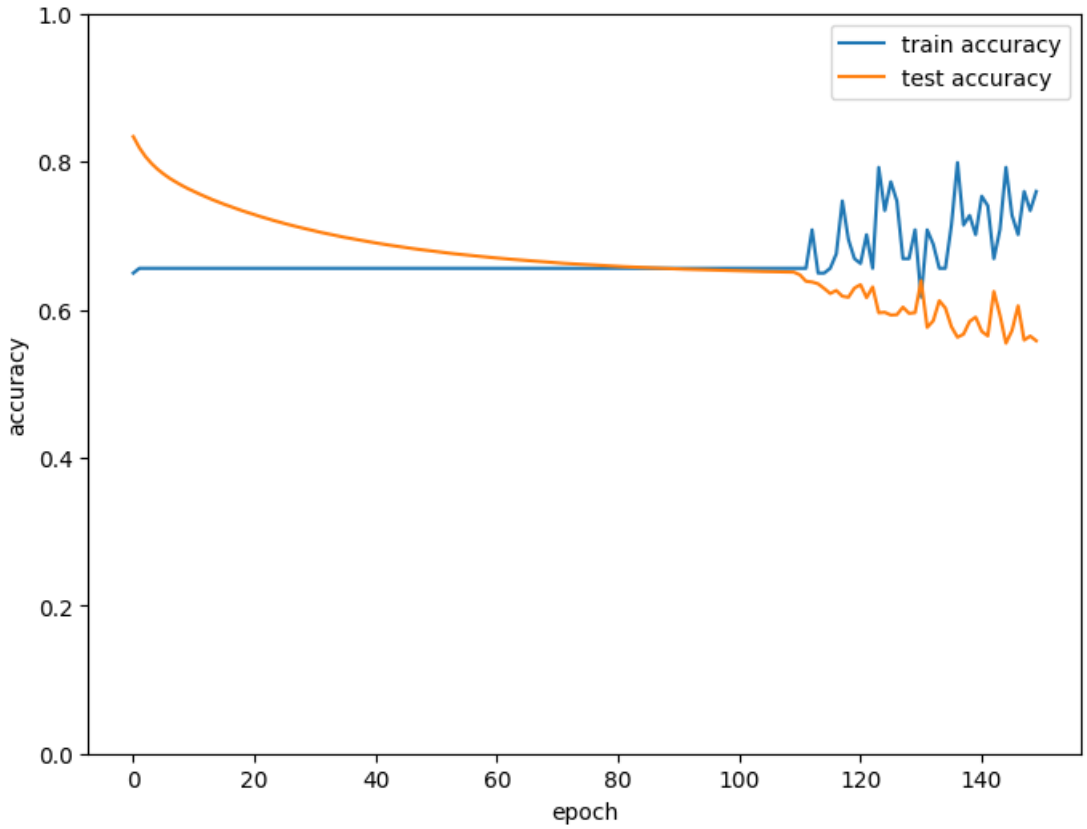
```
accuracy: 0.7987
Epoch 138/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5996 - accuracy: 0.6852 - val_loss: 0.5668 - val_
accuracy: 0.7143
Epoch 139/150
77/77 [==============================] - 0s 2ms/step - loss: 0.6000 - accuracy: 0.6884 - val_loss: 0.5840 - val_
accuracy: 0.7273
Epoch 140/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5925 - accuracy: 0.7064 - val_loss: 0.5898 - val_
accuracy: 0.7013
Epoch 141/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5988 - accuracy: 0.6966 - val_loss: 0.5706 - val_
accuracy: 0.7532
Epoch 142/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5953 - accuracy: 0.7064 - val_loss: 0.5645 - val_
accuracy: 0.7403
Epoch 143/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5887 - accuracy: 0.6982 - val_loss: 0.6245 - val_
accuracy: 0.6688
Epoch 144/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5964 - accuracy: 0.6900 - val_loss: 0.5927 - val_
accuracy: 0.7078
Epoch 145/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5857 - accuracy: 0.6917 - val_loss: 0.5547 - val_
accuracy: 0.7922
Epoch 146/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5969 - accuracy: 0.6933 - val_loss: 0.5717 - val_
accuracy: 0.7273
Epoch 147/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5833 - accuracy: 0.7145 - val_loss: 0.6051 - val_
accuracy: 0.7013
Epoch 148/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5934 - accuracy: 0.6933 - val_loss: 0.5588 - val_
accuracy: 0.7597
Epoch 149/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5908 - accuracy: 0.6998 - val_loss: 0.5642 - val_
accuracy: 0.7338
Epoch 150/150
77/77 [==============================] - 0s 2ms/step - loss: 0.5858 - accuracy: 0.7031 - val_loss: 0.5579 - val_
accuracy: 0.7597
```

In [ ]:
```
plt.figure(figsize=(8,6))
plt.plot(history2.history['loss'])
plt.plot(history2.history['val_loss'])
plt.ylim(0,1)
plt.ylabel('loss')
plt.xlabel('epoch')
plt.legend(['train loss','test loss'], loc="upper right")
plt.show()
print("Maximum accuracy on test data", max(history2.history['val_accuracy']))
```



```
Maximum accuracy on test data 0.798701286315918
```

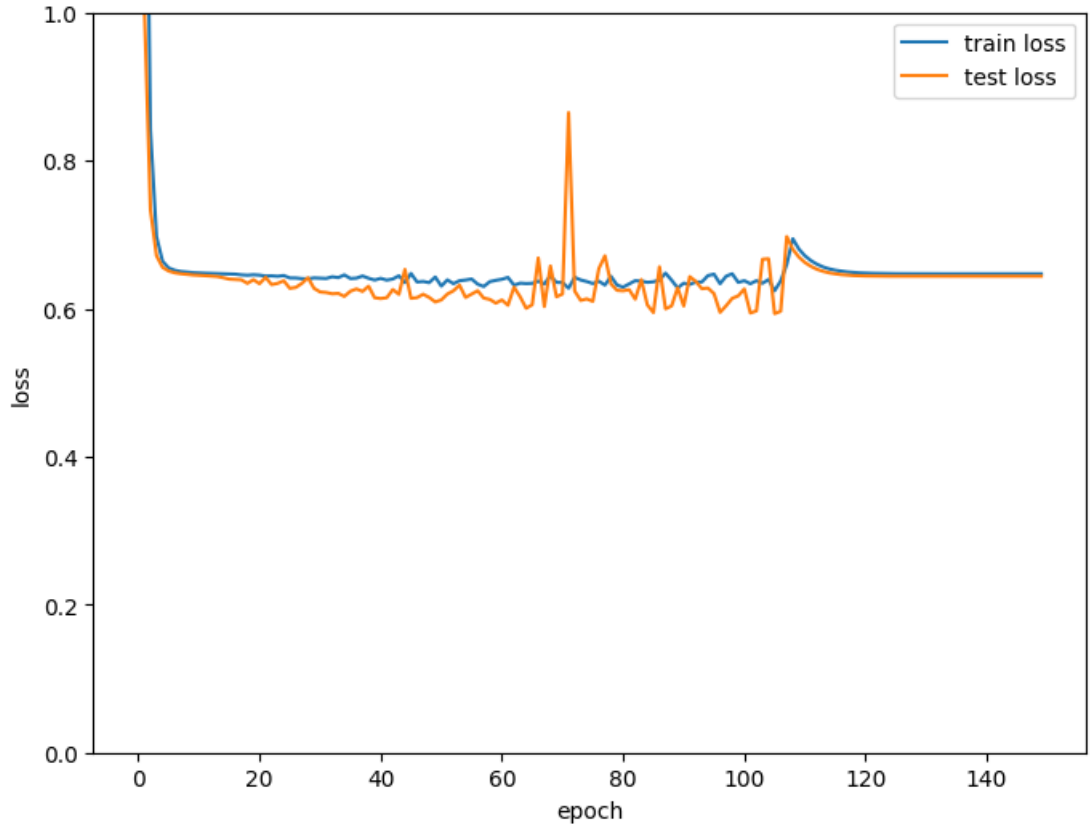
In [ ]:
```
plt.figure(figsize=(8,6))
plt.plot(history2.history['val_accuracy'])
plt.plot(history2.history['val_loss'])
plt.ylim(0,1)
plt.ylabel('accuracy')
plt.xlabel('epoch')
plt.legend(['train accuracy','test accuracy'], loc="upper right")
plt.show()
print("Maximum accuracy on test data", max(history2.history['val_accuracy']))
```




```
Maximum accuracy on test data 0.798701286315918
```

In [ ]:
```
model3 = Sequential()
model3.add(Dense(8, input_dim = 8, activation = "relu", kernel_regularizer=l2(0.5)))
model3.add(Dense(8, activation = "relu", kernel_regularizer=l2(0.5)))
model3.add(Dense(1, activation = "sigmoid"))
model3.compile(loss='binary_crossentropy', optimizer = 'sgd', metrics = ['accuracy'])
history3 = model3.fit(x_train, y_train, batch_size=8, epochs=150, validation_data=(x_test, y_test), verbose=0)
```

In [ ]:
```
plt.figure(figsize=(8,6))
plt.plot(history3.history['loss'])
plt.plot(history3.history['val_loss'])
plt.ylim(0,1)
plt.ylabel('loss')
plt.xlabel('epoch')
plt.legend(['train loss','test loss'], loc="upper right")
plt.show()
print("Maximum accuracy on test data", max(history3.history['val_accuracy']))
```




```
Maximum accuracy on test data 0.798701286315918
```